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(54) INSTALLATION FOR CONTROLLING THE WEIGHT OF TABLETS DURING THE MANUFACTURE THEREOF

(71) We, ATELIERS DE CONSTRUCTION ED. COURTOY, a Belgian Body Corporate, of Steenweg of Bergen, 186 – Halle, Belgium, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to the pressing of tablets from powders.

The increasing throughput capacities and the requirement of manufacturing tablets within still narrower limits have caused the design of devices which control the manufacture automatically.

It has already been proposed to control the weight of tablets by monitoring the exerted compressing forces which are thus used directly for measuring tablet weight. Such control is based on a comparison between the pressure applied and pre-adjusted limite values. According to this prior method, tablets can be rejected individually when the compressing forces fall outside adjustable limits and the filling depth of the dies used can be corrected to compensate the detected differences.

This prior method has various drawbacks. Indeed the ratio between the weight corrections and the pressure corrections is dependent on the kind of the components, the tablet size (diameter and thickness), the hardness of said tablets and the rigidity of the press. In any such case, it is thus necessary to compute the curve which relates said variables (tablet weight and compressing forces). The pressure corrections concerned are larger than the weight corrections concerned which are the cause thereof (usually from 4 to 8 times larger).

To control weights within limits that vary approximately by 5%, pressure corrections of ±20 to 30% have to be applied. The tablets obtained will thus show substantial variations as regards the density thereof, whereby variations will also appear that will influence the pharmacological and mechanical properties as far as they are dependent on the tablet hardness.

According to the invention, there is provided apparatus for manufacturing tablets from powdered ingredients and for controlling the weight of the tablets, the apparatus comprising a die for receiving powdered ingredients for a tablet; a pair of punches which are located one on each side of the die and which are movable towards each other so as to compress powdered ingredients in the die to form a tablet, a first of the punches being movable towards the second punch by means of a pressure roller which is itself movable towards or away from said second punch; a piston operatively connected to the pressure roller for controlling the movement thereof; means for monitoring the displacement of the piston and for providing an output indicative as to whether or not said first punch is operating within predetermined tolerances; and control means operatively connected to said monitoring means for correcting the position of said first punch if said output of said monitoring means indicates that said first punch is operating outside said predetermined tolerance and thereby correcting the depth of the die during the compression of a tablet and hence the thickness of the tablet being compressed, for causing rejection of any tablet produced whilst said first punch is operating outside said predetermined tolerance, and for halting operation of said apparatus if insufficient correction of the position of said first punch is achieved.

Reference is now made to the accompanying drawings which illustrate, by way of example, one embodiment of the invention, and in which:–

Figure 1 is a diagram showing the apparatus according to the invention for

controlling the weight of tablets during the manufacturing thereof, the discs and associated elements of the apparatus being shown in various steps of deployment; and

Figure 2 is a diagram showing the mechanical and electric components of the apparatus according to the invention.

Apparatus according to the invention comprises among others a pneumatically or oleo-pneumatically pressurized chamber 1, which is formed by a space inside a base 2. A piston 3 is fitted inside the chamber 1, the sealing ring 4 of the piston 3 being retained in position by a ring 5. The base 2 is provided at the top with a ring-like part 6 used as a stop. In Figure 1, the piston 3 is shown in its topmost position thereof with the ring 5 pushing against the stop 6. On the top side of piston 3 is further provided a stop comprised of rings 7 and rollers 8 which will be designated hereinafter as stop 7. A cone-shaped part 9 is fastened in the centre of piston 3. In this part 9 is retained a rod 10 with a magnetic head 11, of which the function will be more fully explained hereinafter. The rod 10 passes through a cylinder 12 and forms together with the cylinder 12 an electro-magnetic displacement measuring device for monitoring the movement of piston 3. The cylinder 12 is made fast fixedly connected to the unmoving components of the apparatus by suitable means (not shown).

The cylinder 12 is surrounded by a cylinder 13, of which only the top and bottom parts are visible due to the existence of side openings in cylinder 13 for the fastening in the plane of the cross-section shown in Figure 1, provided for the passage through cylinder 13 of the mounting means for cylinder 12. The outside of the cylinder 13 is provided with a screw thread which extends only over a part of the length of cylinder 13 for cooperation with corresponding internal screw thread on a cylinder 14 which surrounds cylinder 13. The cylinder 13 is prevented from rotating about its axis by suitable means (not shown). The cylinder 14 is connected by means of two pins 15 to yet another cylinder 16 which surrounds cylinder 14, and which bears a crown gear 18 that cooperates with a worm wheel 17. The cylinder 16 is supported inside a housing 19 which is closed at the top by a cover 20.

By rotating the worm wheel 17, the cylinder 16 is rotated which rotates in turn the cylinder 14 *via* the pins 15. Because the cylinder 14 has an internal screwthread and cooperates with the cylinder which is in threaded engagement with the external screw-thread on cylinder 13, the height of cylinder 13 can thus be readily adjusted as desired because it is restrained from rotation when cylinder 14 rotates.

The cylinders 14 and 16 are thus rotatable but the cylinder 13 which is retained against rotation, performs an up-and-down motion as a result from the rotation of cylinder 14. The downwards movement of cylinder 13 is limited by a circular stop 14' which bears on a reduced portion of cylinder 14.

On the top side of cylinder 13 is fastened on arm 21 carrying a pressure roller 24 by means of an U-shaped bracket 22 and a shaft 23. The roller 24 cooperates with a pressure roller 25 which is supported on a shaft 26 of which, in this embodiment, the height is fixed relative to the other immovable parts of the apparatus.

Three coaxial turntables 27, 28 and 29 are mounted for synchronous rotation between the pressure rollers 24 and 25. These turntables and cams associated therewith are shown in Figure 1 in several stages of deployment.

The tablets 30 are compressed in individual dies 31 provided in the turntable 28 which thus operates as a die bearer, by means of two opposed punches 32 and 33. The ingredients for each tablet are supplied from a hopper (not shown) and they are retained between the walls of an open tank (not shown) which bears on the turntable 28, and which is fixed relative to the apparatus. A scraper (also not shown) is further provided for returning any excess ingredients, mostly in powder or grain form, to the tank.

The punches 32 and 33 are respectively supported (as shown in Figure 1) in the turntables 27 and 29, and are respectively provided at the bottom and the top respectively with heads 32' and 33' which cooperate with a set of machine-mounted cams associated with the turntables.

Assuming that the turntables 27, 28 and 29 rotate relative to the non-rotating components of the apparatus (e.g. the pressure rollers 24 and 25) in the direction of arrow 34, the following sequence of operations occurs as a result of the movements of punches 32 and 33 produced by the various cams.

When the punches 32, 33 are pushed towards one another during the engagement thereof with the pressure rollers 24 and 25, the ingredients for a tablet are compressed in the corresponding die 31. The pressure exerted by one pressure roller, in this case the lowermost roller 24, can be adjusted, as described hereinbelow. Immediately after this, the punches 32, 33 move away from one another since the punch 32 is lifted by a ramp 35' of a cam 35, causing ejection of the tablet whilst punch 33 is lifted by the engagement of its head 33' by a cam 36. The cam 36 comprises two parallel flanges which raise punch 33 after each tablet compressing operation, and forces the punch 33 downwards for each tablet compressing oper-

ation.

Once the tablet is ejected from the die 31 by punch 32, and punch 33 is raised by cam 36 and retained in the raised position, the punch 32 is lowered by engagement of head 32' thereof with a ramp 37' of a cam 37. The punch 32 remains in the lowered position into which ramp 37' moves it whilst ingredients for another tablet are collected in the die, whereafter a ramp 38' of a cam 38 returns the punch 32 to its raised position. When the punch 32, which rotates with the turntable 27 again comes into vertical registration with the pressure roller 24, and the punch 33 rotating with turntable 29 comes into vertical registration with pressure roller 25, the punches 32, 33 act to compress the new tablet in die 31 and the procedure described above is repeated. This position of vertical alignment of the rollers 24, 25 and punches 32, 33 is illustrated on the left hand side of Figure 1, and it does of course correspond to that position of the punches 32 and 33 which is not shown between the pressure rollers which are shown diagrammatically on the right hand side of said Figure 1.

A guide 39 has further been provided between cam 38 and pressure roller 39.

To maintain the volume of die 31 within predetermined limits, the cam 38 is adjustable in height as will now be described:

Of the cams 35, 37 and 38 connected to the frame 40, of the apparatus, only cam 38 is adjustable in height. For this purpose, cam 38 is fixed to a cylinder 41 which is fastened in turn to a spindle 42 in such a way that it is prevented from rotation and instead moves up or down when the spindle 42 rotates, depending on the direction of station. The lowermost end of the spindle 42 carries a worm wheel 43 which meshes with a worm gear 44 mounted on a shaft 46 which is driven by a motor 45. It will be apparent that adjustment of the height of cam 38 in this way controls the height at which punch 32 operates during compression of a tablet and trns the volume of the die 31 and a tablet formed therein.

Assuming that the pressure inside chamber 1 is adjustable, the maximum compressing force with which the ingredients are formed into a tablet is also adjustable. This compressing force is so adjusted that the amount of movement of piston 3 is but a few hundreds of millimetres for each compressing. In view of the fluid height inside the cylinder, such small motion of the piston causes no perceptible change in the maximum pressure exerted on the tablets. Consequently all of the tablets will have the same density and the same hardness while the amount of movement of the piston 3 will be a linear function of the tablet weight.

When the mean thickness of the tablets is known, it is possible to compute directly the tolerances which the piston motion can have while retaining the tablet weight within determined limits. Such movements of piston 3 causes identical movements of the magnet head 11 of the displacement measuring device constituted by magnetic head 11 and cylinder 12. This measuring device may be electromagnetic, in which case head 11 is made of U-metal and the rod 10 is of non-magnetic material whilst cylinder 12 includes a primary winding and two secondary windings between which the head 11 moves axially. The output current induced by the moving magnetic head 11 in both secondary windings is compared with an adjustable nominal value. The value of said tolerances above and below which the tablets should be rejected can be adjusted. It is also possible, when a determined number of tablets have been produced outisde of said tolerances, to perform the required correction of the height of the punch 32 during the compression of a tablet by energising the electric motor 45 to rotate the spindle 42 in the appropriate direction.

Reference will now be made to Figure 2 which illustrates diagrammatically the electronic control circuitry required in this embodiment for adjustment of the height of the punch 32.

The output signal from the cylinder 12 of the displacement measuring device is amplified in an amplifier 47 and compared with four respective reference signals in four respective comparators 48, 49, 50 and 51. The reference signals supplied to the four comparators can be adjusted by a common potentiometer 52 and/or by respective potentiometers 53, 54, 55 and 56. The nominal value of the movements of piston 3 can thus be shown, the one of the rejection tolerances by the potentiometers 53 and 54 and the one of the correction tolerances by the potentiometers 55 and 56.

When the movements of piston 3 generate signals that fall outside any one of the values fixed on the tolerance potentiometers, a logic signal will appear at the output of the respective comparator, designated by R+, R−, C+ or C− respectively. In the opposite case the logic signals will be at O level.

The discrimination signals R− and R+ which correspond to the rejection tolerances for too little or too much, are fed to a shift register 57 in which the data is fed forward in stepwise fashion. This forward movement is controlled by a proximity sensor 58 which senses the passage of the uppermost punch 33 as the turntable 29 rotates. Moreover the height at which the proximity sensor 58 is located inside the press is such that the pulse acting on the sensor coincides with the largest movement of piston 3.

The number of steps in the shift register 57 is consistent with the displacement,

represented by the number of pairs of punches, between the location where the compressing occurs and the location where the tablets are discharged.

When data falling outside the tolerances enters the register 57, such data also comes out at the moment where the tablet has reached the station where the discharge is performed. At this moment, the output signal from register 57, which has been amplified in circuit 59, causes the operation of the apparatus which controls the rejection of tablets. This apparatus can operate pneumatically or mechanically. The purpose of the rejection apparatus is to direct the rejected tablets into a different path from that followed by acceptable tablets so that the rejected tablets can be collected separately.

On the other hand the outputs from a predetermined number of succeeding cells of register 57 are compared in a logic unit 61. When the data stored in all of these particular cells is indicative of faulty tablets, said logic unit 61 will cause the apparatus to cease to operate through a suitable relay.

The R+ and R− data will show, by means of two lights 63 and 64 associated with a selector 65, the good or bad operation of the installation. This is obtained by means of a counter 66 which receives the counting pulses from the proximity sensor 58 and which is reset to zero after each complete revolution of the turntables 27 and 29, by a sensor 67 which records the passage of a fixed point 68 on the apparatus rotating table (reference numeral 69 in Figure 2).

When the counter 66 has received a number of pulses which is equal to the number fixed in selector 65 by suitable means 65*a*, a decoding circuit 70 to which the data R+, R− is supplied shows the conditions R+ and R− by means of the lights 63 and 64. It is thereby possible to determine if the pair of punches designated by the number fixed by means 65*a* in selector 65 produces good or bad tablets. The selector 65 thus allows the monitoring of the operation of the succeeding punches.

The correction signals C+ and C− (correction for too much or too little) are consistent with the correction tolerances. These signals appear in two separate registers 71 and 72, in which the data is fed forward in stepwise fashion by means of a signal generated by the proximity sensor 58.

The output signals from the registers 71 and 72 are decoded in respective circuits 73 and 74. When all of the cells inside either of the registers 71 and 72 contain data that falls outside the tolerances, the respective decoding circuit 73 or 74 activates the motor 45 *via* a respective relay 75, 76. The motor 45 moves the cam 38 as described above (Figure 1) to modify the die volume. The motor 45 is stopped as soon as the above-defined conditions are no longer fulfilled. Through the action of the motor 45, the dies 31 are each filled with such an amount of ingredients that the movements of piston 3 remain within the fixed values as shown by the potentiometers 55 and 56 (Figure 2). Therefore the tablets produced will have a density which is substantially constant and a thickness which remains within adjustable limits.

It will be apparent that the pressure roller 25 and its shaft 26 may also be movable towards and away from the turntable 29 by means of a second piston arrangement similar to that of the piston 3 already described, so that the operating position of punch 33 may be adjusted if necessary, in similar fashion to the manner already described in relation to punch 32. In this case, the electronic control circuitry would be operatively connected to control the adjustment of the height of both punches 32, 33 either individually or together if the output of the displacement measuring device monitoring the displacement of the respective piston results in an indication that either or both the punches are operating outside the predetermined tolerance.

WHAT WE CLAIM IS:−

1. Apparatus for manufacturing tablets from powdered ingredients and for controlling the weight of the tablets, the apparatus comprising a die for receiving powdered ingredients for a tablet; a pair of punches which are located one on each side of the die and which are movable towards each other so as to compress powdered ingredients in the die to form a tablet, a first of the punches being movable towards the second punch by means of a pressure roller which is itself movable towards or away from said second punch; a piston operatively connected to the pressure roller for controlling the movement thereof; means for monitoring the displacement of the piston and for providing an output indicative as to whether or not said first punch is operating within predetermined tolerances; and control means operatively connected to said monitoring means for correcting the position of said first punch if said output of said monitoring means indicates that said first punch is operating outside said predetermined tolerance and thereby correcting the depth of the die during the compression of a tablet and hence the thickness of the tablet being compressed, for causing rejection of any tablet produced whilst said first punch is operating outside said predetermined tolerance, and for halting operation of said apparatus if insufficient correction of the position of said first punch is achieved.

2. Apparatus as claimed in claim 1, in which said monitoring means includes a dis-

placement measuring device for producing a signal representative of the position of said piston, and means for comparing said signal with reference signals representative of the upper and lower limits of said predetermined tolerance to produce an output signal constituting said output of the monitoring means.

3. Apparatus as claimed in claim 2, in which said displacement measuring device is an electromagnetic device.

4. Apparatus as claimed in any of claims 1 to 3, further comprising a cam which is disposed to determine the path of said first punch towards the second punch, said cam being itself movable towards and away from said second punch, and an electric motor operatively connected to said control means for moving said cam in dependence on the output of said monitoring means.

5. Apparatus as claimed in any of claims 1 to 4, in which the second punch of the pair of punches is movable towards said first punch by a second pressure roller for the compression of a tablet in the associated die, the two pressure rollers being in registration with each other.

6. Apparatus as claimed in claim 5, in which the second pressure roller is movable towards and away from the said first pressure roller by means of a second piston operatively connected to said second pressure roller, there being second monitoring means, similar to said first mentioned monitoring means, for monitoring the displacement of said second piston, the control means being also operatively connected to said second monitoring means for operating as aforesaid on receipt of an output from said first and/or said second monitoring means that said first and/or said second punch is not operating within said predetermined tolerance.

7. Apparatus as claimed in any of claims 1 to 6, in which a plurality of dies are provided, each die being associated with a respective pair of punches located one on each side thereof, the dies and punches being mounted on a support which is movable so as to bring each die and associated pair of punches in turn to a tablet compressing station for the formation of a tablet in that die, said pressure roller being located at said tablet compressing station so as to engage said first punch of each pair of punches in turn as it arrives at the tablet compressing station, said control means being arranged to identify any pair of punches of which said first punch is not operating within said predetermined tolerance and to halt the operation of the apparatus if said first punch of each of a predetermined number of successive pairs of punches is not operating within said predetermined tolerance.

8. Apparatus as claimed in claim 7, in which said control means includes a shift register which is arranged to receive the output from said monitoring means each time a die and the associated pair of punches arrives at the tablet compressing station; the shift register being arranged so that the respective output for each pair of punches is fed forwards in said shift register in stepwise fashion through a number of cells thereof which is at least equal to said predetermined number, and so that when the respective output for a particular pair of punches reaches the output end of said shift register, the die associated with that particular pair of punches has arrived at a tablet reject station whereby a tablet produced in said die by the particular pair of punches can be rejected if said respective output indicates that said first punch of that pair of punches is not operating within said predetermined tolerance.

9. Apparatus for manufacturing tablets from powdered ingredients and for controlling the weight of the tablets, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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1534061 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

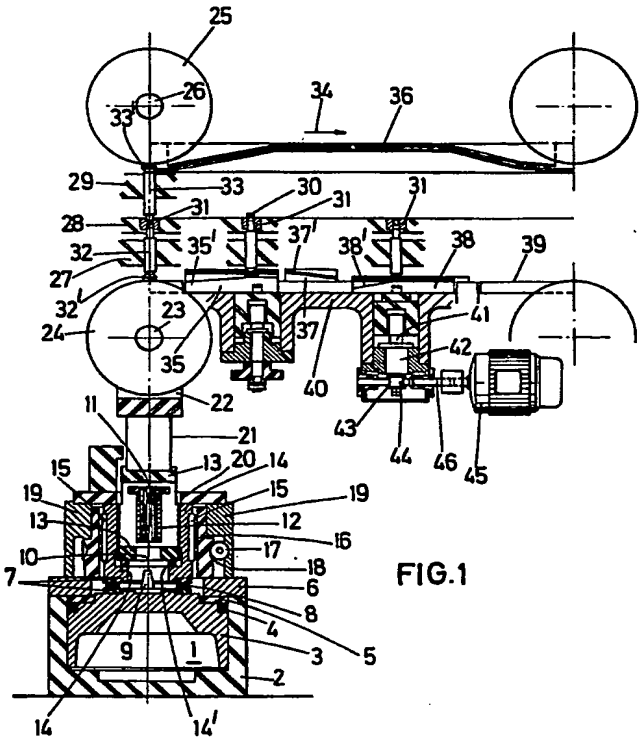

FIG.1

1534061 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

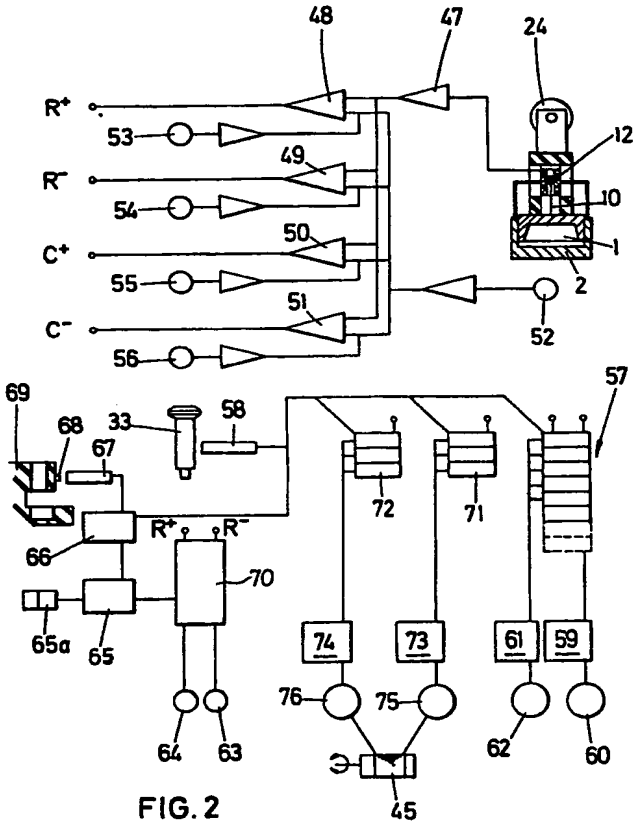

FIG. 2